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ABSTRACT

The reversal errors in the printing of 51 first grade students were examined. These children were asked to print a series of reversible target figures (letters and numbers, such as 2-s, p-q, p-9, and b-d) that were presented alone and with their mirror-image counterparts. To control for the possibility that the mere presence of another figure might be sufficient to produce an error, the targets were also presented with nonmirror-image figures. Although more reversals occurred when the target was printed with another figure than when it was printed alone, the nature of the other figure had no bearing on the number of reversals produced. Correct reproductions occurred far more often than reversals, even when the target was printed with its mirror-image counterpart. Focusing the child's attention on both the reversible target and its counterpart without emphasizing their orientation differences led to a reduction in reversal errors. Taken collectively, these findings opposed the widely held belief that printing reversals stemmed from interference produced by conflicting left-right orientation cues associated with the reversible figures. Apparently, differences in reversible figures do not need to be underscored to prevent interference. (Author/RL)

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Role of the Mirror-Image Counterpart in Producing Reversals When Children Print

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Abstract

Beginning 1st grade children were asked to print a series of reversible target letters and numbers. These were presented alone as well as together with their mirror-image counterparts. To control for the possibility that the mere presence of another figure might be sufficient to produce an error, each target was also presented with a non-mirror-image letter or number. Printing took place from memory immediately after the children saw the letters and numbers on slides. The results showed that although more reversals occurred when the target was printed with another figure than alone, the nature of the other figure had no bearing on the number produced. Moreover, even when the target was printed with its mirror-image counterpart, correct reproductions occurred far more often than reversals. Together these findings question the widely held belief that printing reversals stem from interference produced by the conflicting left-right orientation cues associated with the reversible letters and their counterparts. Also, focusing the child's attention on both the reversible target and its counterpart without emphasizing their orientation differences, led to a reduction in reversal errors. This too runs counter to the assumption that these differences need to be underscored in order to prevent interference from taking place.

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Role of the Mirror-Image Counterpart in Producing Reversals when Children Print

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The present report is the second in a series (Simner 1980) concerned with reversal errors children make when they print. Among the various accounts given to explain this behavior it is widely held that reversals ultimately stem from the child's lack of attention to, memory for, or confusion over the left-right orientation cues of letters and numbers (Bannatyne 1971, 1972; Chapman, Lewis & Wedell 1970; Davidson 1935; Fellows 1968; Frostig 1963; Kephart 1971; Kinsbourne & Caplan 1979). Moreover, this confusion is said to be further compounded in the special case of letters having mirror-image counterparts such as b and d (Enstrom & Enstrom 1969; Myers 1963; Smith 1977). Here it is argued that the left-right problem is aggravated due to interference produced by the opposing orientation cues belonging to these letters because they are similar in form but face in opposite directions. In other words, it is assumed that without considerable drill emphasizing their orientation differences, more reversals will occur if the letter b for example, is printed together with its mirror-image counterpart d than alone. The outcome of the following two experiments led me to question this view.

Experiment 1

Subjects:

Fifty-one non-repeating children (25 male, 26 female) were tested individually at the onset of printing instruction early in the fall term of Grade 1.

Method:

Each child was shown slides of the following seven reversible target letters and numbers: 2, 9, b, p, D, E, and N. The specific letter-shapes (projected as black against a white background) were those used in the school system and subtended a visual angle of approximately 3^{o}. Each target was presented both alone and on separate slides together with a mirror-image counterpart. For example, 2 appeared with S, 9 with p, b with d, p with q, etc. Also, using a further set of slides, each target appeared together with a non-mirror image letter or number. This served to control for the possibility that the mere presence of another figure might be sufficient to produce an error. Here for instance, 2 appeared with 7, 9 with q, b with h, p with B etc. It should be pointed out that each control figure was chosen to resemble the target in orientation thereby eliminating the likelihood of interference due to orientation differences. In addition, when two figures appeared together on the same slide they were aligned horizontally (counterbalancing for position) since work with geometric figures suggests that this alignment is likely to aggravate further this left-right orientation problem (Huttenlocher 1967).

The entire series of slides was administered using two different random orders. Each slide remained on the screen for 2.5 sec. Immediately after the slide was removed from the screen the child was asked to print all of the

letters or numbers that appeared on the slide from memory. This was done because printing from memory was considered to provide a more critical test of the interference hypothesis. In other words, if the left-right orientation cues of these letters and numbers are confusing, attempting to recall the opposing orientation of both the counterpart and target at the same time from memory should generate even more interference.

Each reproduction was recorded on data sheets by an observer standing behind the child as the child printed. Observer reliability obtained from a subsample of 12 children showed agreement in approximately 98% of the cases. Mirror-image reversals were said to have occurred when all of the parts of the target were reproduced correctly but rotated 180^{o} about a vertical axis (e.g., b for d).

Results

Contrary to prediction, the findings showed that although more reversals occurred when the target was printed with another figure, the nature of the other figure had no bearing on the number produced. That is, the number of reversals per child generated by the target when printed with its mirror-image counterpart ($M = .45$) did not differ reliably from the number generated by the target when the target was printed with its control figure ($M = .47$). On the other hand, significantly more reversals took place under each of these conditions than when the target was printed alone ($M = .18$; $z = 2.74$ and 2.94 respectively, $p < .007$ two-tail). In other words, it made little difference whether b for example, was printed with its counterpart d or its control h. As long as either appeared together with b more reversals occurred than was the case when b was printed in isolation. Therefore, these results provide no reason to believe that the orientation differences that exist between the reversible letters and their mirror-image counterparts cause a unique form of interference

that in turn is responsible for reversal errors.

In addition to these main findings, the results also showed that reversal errors were extremely infrequent relative to correct reproductions. This was so independent of the nature of the target being printed or the condition under which printing took place. Specifically, correct reproductions exceeded reversal errors for each target letter whether the target was printed alone (X^2 = 36.3 to 51.0, df = 1, $p < .01$ two-tail), with its mirror-image counterpart (X^2 = 62.7 to 90.4, df = 1, $p < .01$ two-tail), or its control (X^2 = 37.7 to 69.2, df = 1, $p < .01$ two-tail). In fact when the counterpart and target were printed together, less than 1% of the total number of reproductions generated under this condition appeared as reversal errors. Hence, in addition to questioning whether the counterpart has a unique interfering role, this added evidence indicates that even if such interference does take place, its affect must be negligible since reversal errors are extremely rare.

Experiment 2

The foregoing evidence provides a serious challenge to the interference hypothesis by showing that children are not particularly troubled when asked to print a reversible letter together with its mirror-image counterpart. This next experiment provides added reason to question this hypothesis by demonstrating that reversal errors decline in frequency when the child's attention is drawn to the overall properties of both the target and its counterpart <u>without</u> emphasizing their orientation differences.

Subjects:

Thirty-eight non-repeating children (19 male, 19 female) tested individually in the mid-fall of Grade 1.

Method:

The task used in Experiment 1 was readministered twice approximately 25 days apart. During the 1st session the procedures described above were employed for both the Experimental (N = 19) and Control Group (N = 19). During the 2nd session children in the Experimental Group were instructed to pay close attention to the overall detail of each of the letters and numbers appearing on the slides. To ensure adequate attention a token in the form of a stamp used by the child's teacher to indicate good performance was awarded for each letter and number reproduced from memory that looked exactly like that shown on the screen. The children in the Experimental Group were also told that at the end of the 2nd session the child with the most tokens would receive a doll (females) or a car (males). Tokens were withheld when errors of any type occurred in any of the reproductions. This was done specifically to avoid focusing the child's attention on the target alone, its orientation relative to the counterpart, or on reversal errors in particular. In addition, the slides remained on the screen for 5 sec instead of 2.5 sec as was the case in Experiment 1. The Control Group was treated the same during both the 1st and 2nd session.

Results

The data obtained from the Experimental Group showed a reliable reduction in reversal errors between the 1st (M = .53) and 2nd session (M = .16; Wilcoxon test: T = 7.0, N = 11, p = .02 two-tail) when the target appeared with its counterpart. This did not happen in the Control Group (1st session M = .39; 2nd session: M = .44). Moreover, there is some reason to believe that this decline in reversals shown by the Experimental Group did not result because the children became aware of the importance of left-right orientation cues

through interspersed trials of reward and non-reward. In other words, it could be that by not receiving tokens when reversals occurred the children in the Experimental Group might have come to realize that orientation was a critical cue and for this reason began to attend to the left-right differences associated with the target and its counterpart. However, based on the trial number during which the 1st error occurred for the Experimental Group, reversals took place later in the 2nd session ($M = 24.1$) than in the 1st session ($M = 18.1$; Wilcoxon test: $T = 24$, $N = 15$, $p < .05$ two-tail). This was not true for the Control Group. Therefore, it would seem that correct reproductions were evident before children were able to profit from feedback received as a result of having made an orientation error.

Discussion

In summary, the main findings from Experiment 1 showed that more reversal errors occurred when the reversible letters were printed with their mirror-image counterparts than alone. However, the same result was obtained when these letters were printed with non-mirror-image letters or numbers. Therefore, there is little reason to believe that the opposing left-right orientation cues that characterize the difference between a reversible letter and its mirror-image counterpart generate a unique form of interference that causes reversal errors to take place. By the same token, Experiment 2 revealed that focusing the child's attention on both the reversible letter and its counterpart without emphasizing their orientation differences produced a decrease in reversal errors. This too runs counter to the assumption that these orientation differences need to be underscored in order to prevent interference from taking place. In general then, the findings from both

experiments seriously question the widely held view that mirror-image letters and their counterparts cause special problems among beginning printers because of their orientation differences. Therefore, it would seem reasonable to propose that current teaching practices which emphasize drill and sensory-motor training to ensure that children recall the orientation cues of the reversible letters and numbers might be unnecessary. In other words, according to the present findings, it would seem that these practices are directed toward correcting a deficiency in the beginning printer which not not appear to exist.

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